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A SPECIAL FLASK FOR THE RAPID DETERMINATION OF WATER IN FLOUR AND MEAL.

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INTRODUCTION.

The special flask which is described in this bulletin is used in connection with the Brown-Duvel tester described in Circular No. 72 of the Bureau of Plant Industry, United States Department of Agriculture, entitled "A Moisture Tester for Grain and Other Substances and How to Use It," by Dr. J. W. T. Duvel. The special flask, shown in figure 1, has double walls and was developed for commercial work so that a quick and accurate test could be made of finely ground material, such as flour and meal. The single-walled flask described in the circular mentioned is not suitable for testing finely ground substances, as it does not always give accurate results. The meal when tested in such a flask frequently burns badly at the bottom, and the flask does not clean well and soon breaks, while the double-walled flask may be cleaned without trouble and does not break easily.

One of the principal causes why corn meal and other finely ground materials deteriorate is the water which they contain. The manufacturers of these finely ground products can largely eliminate the excess water in their meal and flour by proper precautions. The amount of water in flour or meal can easily be tested in a few minutes by the use of this special flask, thereby determining whether they contain too much water for safe transportation or storage.

The tester consists of two or more compartments, so that one or more duplicate sample tests can be run at the same time. There is a flask for each compartment and a gas, alcohol, or gasoline burner beneath each one. Figures 2 and 3 show an external view of a standard 6-compartment water tester ready for use.

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DESCRIPTION OF THE SPECIAL FLASK.

The flask, the dimensions of which are shown in figure 1, is double walled and can be made of copper or glass. The inner flask has a capacity of approximately 900 cubic centimeters and the space between the two walls should hold not less than 250 nor more than 300 c. c. If the flasks are made of copper, the thickness of the copper before it is spun should be 22 thousandths of an inch or 16 ounces to the square foot. The copper flasks will have to be made in two sections and soldered together in the middle with a very hard solder. The soft solder commonly used by plumbers is not suitable for this work. Success with these flasks has been attained only when they were soldered together with a silver solder. The neck of the flask must be of but one thickness of copper, for if it is too heavy it will melt the rubber stoppers.

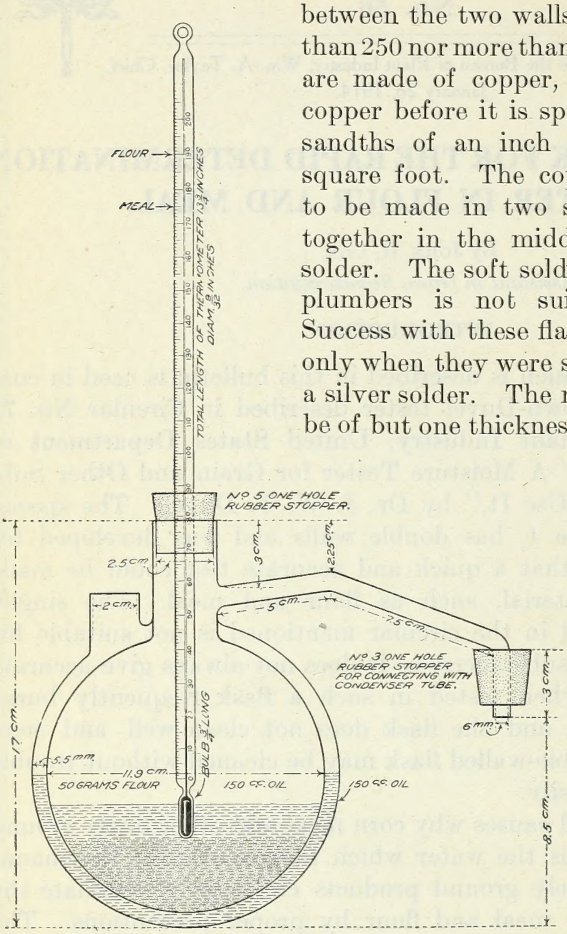

FIG. 1.—A distillation flask, showing its dimensions and the correct adjustment of the thermometer.

The glass flasks when made in accordance with the proper specifications will give as accurate results as the copper ones. They should be made of the best grade of resistant glass and well annealed, and the necks should be sufficiently heavy to stand tight corking. When 150 c. c. of oil is poured in between the two walls, the top of the oil should be about halfway up the sides of the flasks. If the flasks do not meet these specifications they should not be used.

HOW TO MAKE A WATER TEST OF FLOUR OR MEAL.

To make a water test pour 150 c. c. of oil in the inner flask and then 150 c. c. of oil between the two walls. Weigh an average sample of 50 grams on scales that are sensitive to at least one-twentieth of a

gram and put it into the inner flask by means of a long funnel, so as to drop the material well down into the inner flask; otherwise, the material will collect around the neck and will be liable to fill up the tube which leads from the flask to the condensing tube.

SPECIFICATIONS FOR THE THERMOMETER.

The thermometer should be approximately 13 inches long and nine thirty-seconds of an inch in diameter, with a bulb approximately three-fourths of an inch in length. The thermometer should be grad-

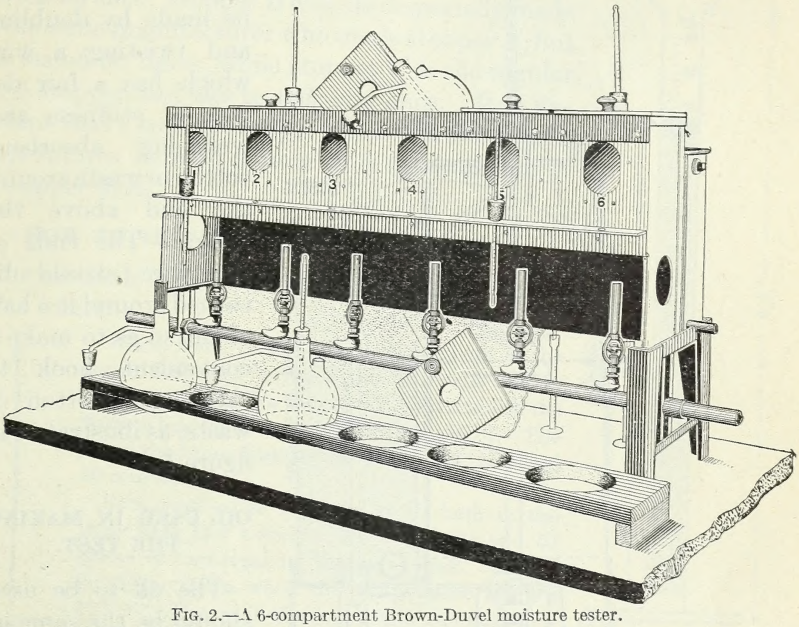

FIG. 2.—A 6-compartment Brown-Duvel moisture tester.

uated in whole degrees from 0° to 210° C., with the graduations etched on a stem having a white background.

ADJUSTMENT OF THE THERMOMETER.

The thermometer is more easily adjusted in the copper flask by first putting the bulb in flour, leaving a fine white coating of the substance on the thermometer. It is then put into the flask and quickly withdrawn, so as to see the height of the oil on the bulb, which should be so placed in the flask that it is approximately three-fourths covered with oil, as shown in figure 3. If the thermometer is not properly adjusted, the results will be inaccurate.

DESCRIPTION OF THE GRADUATE AND HOW TO READ IT.

The special graduate shown in figure 4, used when a 50-gram sample is tested, is just one-half the volume of the graduate in regular

use and gives the percentage of water direct without multiplying by two, which must be done in employing the one commonly used.

Usually a small quantity of oil is carried over into the measuring cylinder and collects on the surface of the water, so that the readings should be made at the bottom of the meniscus between the oil and the water, as shown in figure 4. After the test has been made the graduate should be emptied and wiped dry. A cleaner can be made by doubling and twisting a wire which has a fair degree of stiffness and wrapping absorbent cotton or waste around the end above the hooks. The ends of the wire should be turned around in a half circle, so as to make a convenient hook to catch the cotton or waste, as illustrated in figure 5.

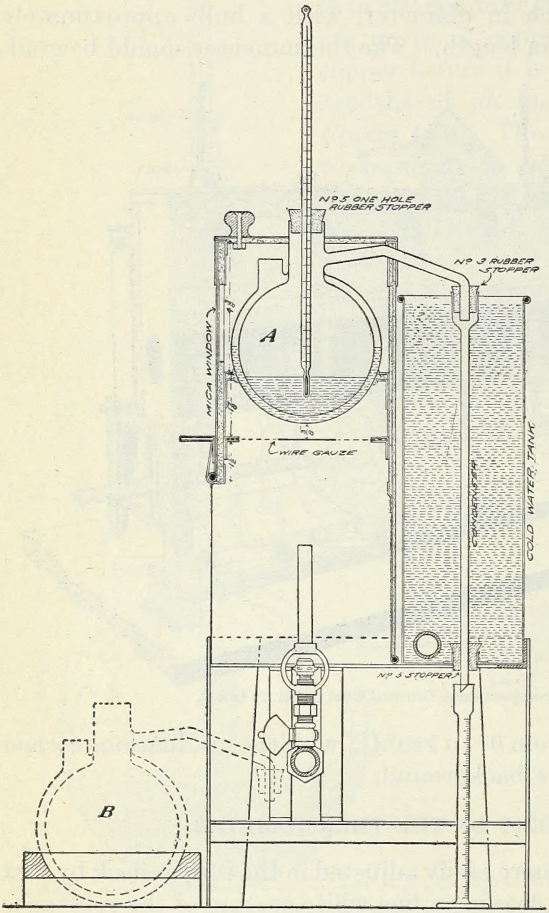

FIG. 3.—Sectional view of the Brown-Duvel moisture tester, showing the various parts connected for use. *A*, Distillation flask in position, three-eighths of an inch above the wire gauze; *B*, distillation flask in the wooden rack used only during the filling.

OIL USED IN MAKING THE TEST.

The oil to be used should be the same as that specified in Circular No. 72 of the Bureau of Plant Industry, in which it is described in part as follows:

In making tests a good grade of mineral engine oil should be used. The oil must be free from water, should have a flashing point in open cup of approximately 200° to 205° C. (392° to 401° F.), and preferably a viscosity between 10 and 15 (Engler) at 20° C. (68° F.). After the tests are completed and while the oil is still hot, empty the contents of the flasks into a strainer to recover the oil, which can be used repeatedly. A funnel strainer fitted to the mouth of a 3 or 4 gallon milk can is serviceable and inexpensive.

The funnel strainer mentioned is shown in figure 6. There should be a small quantity of absorbent cotton placed in the bottom of this strainer, so that only the oil can collect in the can beneath.

STOPPERS TO BE USED.

If copper flasks are used, a special No. 5 rubber stopper will have to be made, so as to stand the high temperature. Figure 7 shows the results of the heat on three rubber stoppers when run in a double-walled copper flask. The temperature of the oil in the inner flasks in each of these tests was 190° C. when the flame was extinguished. Stopper A was made especially to stand high temperatures and was tested once; stopper B was also especially made by the same manufacturer who made stopper A, but was tested 30 times, while stopper C is the regular No. 5 stopper and was tested only once. It is important that a special stopper which will stand high temperatures be used if flour and meal are run in the copper flask.

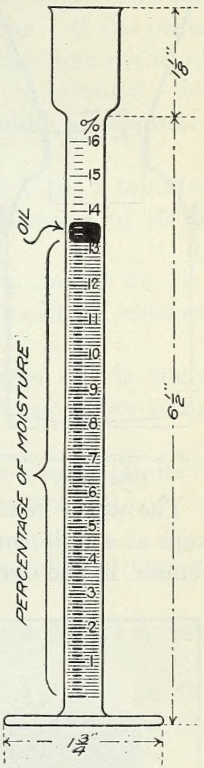

FIG. 4.—Graduated measuring cylinder, showing 13.2 per cent of moisture.

HOW TO TEST DIFFERENT SUBSTANCES.

The methods used in testing flour and corn meal are as follows:

Wheat flour.—Use 150 c. c. of oil both in the inner flask and between the two walls and 50 grams of flour in the inner flask. Extinguish the flame when the temperature reaches 190° C. The oil in the inner flask should reach 190° in about 30 minutes.

Corn meal.—Use 150 c. c. of oil both in the inner flask and between the two walls and 50 grams of corn meal in the inner flask. Extinguish the flame when the temperature reaches 175° C. The oil in the inner flask should reach 175° in about 26 minutes.

FIG. 5.—Test-tube cleaner.

TIME OF TEST.

One of the most important factors in getting correct results in the test here described is the time in which it is made. Unless the flame is under the direct control of the operator and run in accordance with the following directions, the test will not be accurate.

The flame should be so adjusted that the temperature of the oil in the inner flask will reach 120° C. in 15 minutes and rise approximately 5 degrees for every minute after that until it reaches the desired temperature. This will require 14 minutes for oil containing flour after it gets to a temperature of 120° to reach a temperature of 190°, and 11 minutes for oil containing meal after it gets to a temperature of 120° to reach a temperature of 175°. If the oil in the inner flask reaches a temperature of

120° in less than 15 minutes, the flame should be turned down, so that the temperature will rise approximately 5 degrees a minute. If it takes more than 15 minutes to reach 120°, the flame may be turned up, so that the temperature will rise at the rate mentioned. The temperature of the oil in the inner flask should rise from 120° to 150° in approximately 6 minutes. If the oil between the walls is not emptied and another test is made before the oil gets cool, the time required to reach 120° will be less than 15 minutes with a proper flame.

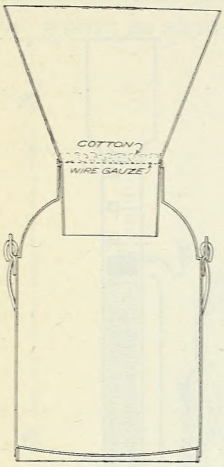

FIG. 6.—Strainer for recovering the oil.

METHOD OF FINDING THE PROPER TEMPERATURE.

The proper temperature at which to extinguish the flame in the apparatus was found by checking duplicate samples in the common type of double-walled water oven that was 11 inches high, 11 inches wide, and 10 inches deep, outside dimensions, and having a 1-inch space between the outer and the inner wall for the water. The water in the oven was kept boiling by two gas flames and was kept at a uniform height. The different substances were allowed to remain in the oven until they came to a constant weight.

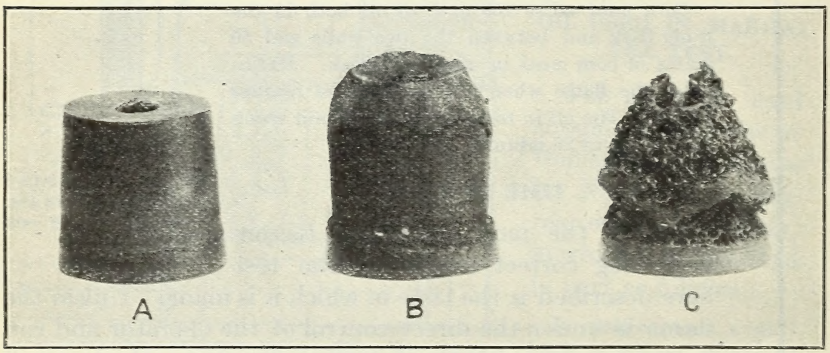

FIG. 7.—Rubber stoppers, showing the effect of heat when tested in a copper flask. Stopper *A* was tested once, *B* 30 times, and *C* once.

POINTS TO REMEMBER.

(1) Both in the inner flask and between the two walls 150 c. c. of oil should be used.

(2) The thermometer in the copper flasks can be easily adjusted by so placing the bulb of the thermometer in flour or meal that a thin coating is left upon it. The thermometer is put into the flask and

quickly withdrawn, so as to see the height of the oil on the thermometer, which should be so adjusted that the bulb will be three-fourths of its length in the oil.

(3) A moderate, steady flame should be kept, which will take 15 minutes for the oil in the inner flask to reach 120° C., 26 minutes for the entire test for corn meal, and 30 minutes for flour. If the oil is hot between the two walls when the test is begun, the time required to reach 120° with a proper flame will be less than 15 minutes. In such instances the time from 120° to 150° C. should be approximately 6 minutes.

(4) The thermometer should rise about 5 degrees C. in 1 minute.

(5) After the flame is extinguished there is an increase of 10 to 15 degrees C. in temperature.

(6) Before taking a reading the distillation flask should be disconnected from the condensing tube and all the moisture allowed to collect in the graduate.

(7) The outside flask can be corked while the inner one is being emptied, and the same oil may be used five or six times before being changed.

(8) Cotton should be placed at the bottom of the funnel strainer.

(9) The inner flask should be rinsed out with an extra 150 c. c. of oil after it is emptied of the corn meal or flour.

(10) Only special stoppers of the best quality should be used in the necks of the copper flasks.

(11) To insure accurate results when testing flour or meal a special measuring graduate should be used.

(12) For correct results the first run in new flasks should be discarded and the results of the second one taken; also, if the apparatus has not been used for several days, a second run should be made.

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